

Plating and Industrial Waste Treatment at the Expanded Plant of
Fisher Body, Elyria, Ohio for Presentation at the
Purdue Industrial Waste Conference

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The Fisher Body, Elyria Plant is a major manufacturer of Hardware and electroplated parts for the automobile industry. This plant is located in a rural area on the Western edge of the city of Elyria. Cleveland is approximately 35 miles to the Northeast.

The treatment plant effluent now averages one and one half million gallons daily. This discharges into a large storm sewer which in turn joins the Black River one mile east of the plant. The point of confluence is approximately one-fourth mile upstream from Cascade Park. The park is an attractive recreational area maintained by the city of Elyria. Inasmuch as our effluent flows to a surface stream, we are required to operate under the provisions of a permit from the Ohio Water Pollution Control Board at Columbus.

The Black River is considered a major tributary of Lake Erie. The increasing attention being given to the condition of the Great Lakes has in turn focused more attention on those industries returning water to it.

In this presentation, I will attempt to cover the more important aspects of the pollution abatement program of the General Motors, Elyria Plant and to show also the extent of our activity to prevent pollution of Lake Erie.

Fifteen years ago there simply weren't many industrial waste treatment plants around that were designed to handle the wastes we were faced with.

Our treatment plant design then had to be based on the best available information, the experience of our own engineers, and what we felt would do the best possible job. Looking back, this installation has to be considered one of the pioneer industrial waste treatment plants in the State of Ohio.

Fortunately, most of the basic ideas incorporated into the original design, were good ones and continue to serve quite adequately. Shortly after the initial plant start-up however, certain very definite shortcomings became obvious. Modifications were necessary to meet the requirements of good waste treatment practices.

This discussion will concern those factors leading to the design, development and operation of our recently expanded treatment plant, with the hope that this information may be beneficial to others faced with similar problems.

Fisher Body, Elyria, is basically a plating, anodizing and hardware manufacturing plant. The production of such items as automotive grilles, instrument panels, anodized aluminum trim, plus various other interior and exterior trim items require large volumes of water. The raw waste flow may be described as rather weak solutions of acid or alkali and various suspensions incidental to our type manufacturing. In this presentation we will be considering four general types of waste. These are: (1) Acid-alkali or metal bearing wastes (MBW), (2) Chromic acid wastes i.e.

solutions compose of primary, secondary and tertiary chrome rinses, (3) Cyanide wastes and rinses and (4) Cleaners, pre-soaks, detergents, wetting agents and so forth which are used in preparing the work part for the plating process.

ACID ALKALI SYSTEM

When our original treatment plant was built in 1956, roughly 90% of the process flow was then directed into this system (Fig. 1) including all plating rinses, weak acids, alkali, and chrome wastes. As a matter of fact, everything, with the exception of the cyanide wastes, strong cleaners and caustic rinses went into this system.

Around each plating unit and extending to various points throughout the plant is a series of shallow trenches approximately one foot deep and one foot wide. They are actually cut into the floor. The top of the trench system is level with the floor and is covered with three-quarter inch steel plate for easy inspection and cleaning. The trenches intersect with a larger vitreous tile sewer system which drains to a main acid-alkali collecting sump (Fig. 1) of 10,000 gallons capacity. Four acid-resistant pumps located above this sump evacuate it. Everything in this particular system up to this point is essentially unchanged from the original design.

As mentioned earlier, on start up, our chrome wastes were consolidated with all the other plant wastes (except cyanide) into one common tank of 75,000 gallon capacity. This tank was in effect the main receiving and treatment tank. The idea of treating all the chrome in a rapidly moving, high volume stream was a real challenge. There simply was not enough time for pH

adjustment, usual acidification. Furthermore, almost simultaneous chemical reduction was required. The sodium bisulfite feeders had to be operated at maximum to cope with the wide variance in chrome concentration. Reaction and mixing times were very inadequate. Occasionally, again due to the varying concentration of chrome wastes in the incoming flow, of up to 1200 gallons per minute, we had partially treated stronger wastes prematurely displaced by less significant weaker wastes. Our first major change then was to isolate all the stronger chrome and as much of the weaker chrome rinses as possible into an adjacent surge tank (Fig. 2). With this change we were then able to treat most of our chrome on a batch basis. While this improvement brought us within range of our objective, which was total removal of chrome from the final effluent stream, there was still a more or less persistent presence of trace amounts of hexavalent chrome in the high flow stream that would occasionally escape treatment.

After the isolation of most of the chrome from the acid-alkali system, the principal treatment still required in the MBW system was lime neutralization to permit the metallic-hydroxide sludge formation. This reaction was accomplished in the clarifier draft tube.

The lime neutralization process in the clarifier draft tube was usually satisfactory. Problems did occur however during periods of higher flow or when substantial amounts of acid or treated chrome was being transferred to it. Again, the displacement rate was such that the required reaction time for both the metallic hydroxide and floc formation was simply insufficient. Turbidity

and some carry-over would sometimes result. The pH of the final effluent would vary considerably. Our solution to this problem was to remove the lime neutralization-coagulation process from the clarifier draft tube and apply it one step earlier, that is, directly into the MBW receiving tank (Fig. 3). Thus all neutralization including that of the reduced chrome was accomplished with lime in the MBW tank. It was then possible to mix the lime much more thoroughly since we were now working in a smaller tank with a considerably higher mixing rate; a condition not attainable in the draft tube. This change solved many of the neutralization problems which we had been experiencing. Effluent quality improved immediately; lime usage and sludge volume decreased substantially. This change worked so well that later on when we were designing our expanded plant the idea was incorporated into what became known as a "blending tank". The new blending tank had incorporated into it all the principles of the draft tube, but outside of the clarifier.

There was one other device that developed from this change. We began using a lime slurry; continuously recirculating it to the feed tank to minimize settling. An in-line, air operated valve was designed to respond to a signal from a pH sampler receiving a continuous stream from the blending tank. When the pH dropped the valve opened and lime was fed. When the pre-set upper pH was reached the valve closed. This is a very simple, but extremely effective device which operates practically trouble-free, performing an important function in our neutralization process-- here again this technique was also included in our new plant.

In our expanded plant the original MBW tank which had a capacity of 75,000 gal. has been replaced by four tanks of 220,000 gallons each, or a total of 880,000 gal. capacity. (Fig. 4). This change enabled us to convert from a flow-through to a batch system. Now, when one of the four MBW tanks is filled, the incoming raw waste is diverted to another tank. A sample is taken and an analysis is made. The necessary chemicals are then added. After allowing adequate mixing time, the tanks are re-checked for the completion of the reaction. If the test is satisfactory the tank is pumped out to the blending tank for neutralization with lime for the required metallic-hydroxide formation. Then a coagulant aid is added with moderate agitation to promote rapid flocculation. From the blending tank the treated wastes flow to the clarifier for final clarification. Within the clarifier sludge settling and final separation takes place. The clear effluent overflows to a weir and then to the storm sewer. The particulate matter settles out and forms the sludge.

CHROME

Chrome wastes are collected in sumps at the plating units. Stainless steel pumps move the solution through a 6 inch pipe to collecting tanks. The tanks have a combined capability of 450,000 gallons (Fig. 4).

An unusual method of chrome treatment was developed at our plant which I would like to briefly describe.

Shortly after the removal of the chromic acid waste flow from the acid-alkali system, we began some original work involving powerhouse stack gases to treat chrome wastes. The general idea

was to wash out the sulfur dioxide from the stack gas and use it as the chemical reducing agent for converting the hexavalent chrome to the trivalent stage. Preliminary tests indicated the desired reaction was well within the realm of practical possibilities. Actually, the reaction is a simple, straight-forward process which has proven highly effective. The process was first presented in 1959 at the 14th Purdue Conference. Since that time, the greater part of the actual chemical reduction of chrome wastes at our plant has been accomplished by the use of reclaimed power-house flue gas.

What is involved essentially in this method of chromic acid waste treatment is a synergistic-type reaction in which air and water pollutants are intimately mixed and simultaneously neutralized. The sulfur dioxide output from the stacks is of course directly proportional to the sulfur content of the coal itself. We divert the required amount of smoke from the hot power-house stacks through a 20 inch steel duct to the scrubbers on a platform adjacent to the chrome treatment basin (Fig. 4). Here the sulfur dioxide is literally "scrubbed" out with the chromic acid waste solution, thus the two pollutants undergo a primary chemical reaction necessary for their final neutralization. On those rare occasions when additional treatment is required, it is accomplished with commercial sodium bisulfite. More often however, excess sulfur dioxide is recovered which can be further utilized.

One additional feature of this system is that it also removes from the stack some of the fly ash which evades the dust collection system. Originally it was thought that fly wash would complicate

our treatment, actually however, we have found that these particulates generally enhance the flocculation and precipitation rate of certain organic materials in the main flow (MBW) system. The flue gas chrome treatment process was originated at the Elyria Plant several years ago as a practical and economical method of both air and water pollution control. It has proven very effective, and in some areas exceeded expectations. This method has proven sufficiently reliable over several years of operation so that two large scrubbers were added to our expanded plant, increasing our scrubbing capacity substantially.

There are a few other advantages to this method of treating chrome wastes. Inasmuch as the scrubbers operate around the clock, what usually happens is that the tank being scrubbed is not only totally treated, that is chemically reduced, but in addition, residual or excess sulfur dioxide is accumulated. This along with the acid which is also produced from the scrubbing process, is utilized to help treat traces of chrome in the main flow system which tends to be alkaline--thus reducing the amount of commercial acid and lime otherwise required.

The final treatment of chrome wastes involves neutralization with liquid lime; that is, raising the pH of the trivalent chrome to a reading of 8 and allowing the chromium hydroxide to precipitate. This neutralization is accomplished by pumping first to the MBW tanks and then to the blending tank where it combines with other previously treated wastes.

CYANIDE

The cyanide collecting and treatment system is essentially the same now as originally designed (Fig. 4). Separate sumps at

the plating units collect the cyanide solution. From there it is pumped through a four inch line to one of three holding tanks with a capacity of 185,000 gallons each.

In the treatment of the cyanide, our objective is to first destroy the free cyanide. Originally, the destruction of free cyanide only was deemed adequate treatment. Not long after, however, we changed to total destruction of cyanide, that is to the carbon-nitrogen end products. We do this in two steps; chlorine is added in the form of commercial sodium hypochlorite solution. This provides the oxidation reaction. After several hours of mixing the batch is checked for free chlorine residual. When this test is positive, the cyanide waste is then transferred to one of four large acid-alkali tanks. The batch is then rechecked for free chlorine. When the test is positive, the pH is carefully lowered and a final total cyanide determination is run before transfer to the blending tank where lime is added and final pH adjustment is made.

Another change in the cyanide system concerned isolating the cyanide to a greater degree than originally provided. Consolidation into the cyanide system of caustic cleaners or other alkaline wastes proved to be detrimental to the cyanide treatment process. The presence of these wastes or any foreign material provided interference with the chlorination, inasmuch as the chlorine demand of these materials usually had to be satisfied before oxidation of the cyanide was complete. As a result of this, it was necessary to totally isolate cyanide from all other wastes. Once this was done cyanide treatment was a lot easier.

CLEANERS

A major improvement in our new plant is the inclusion of a separate system for isolation and treatment of cleaners.

The electroplating industry consumes large quantities of highly efficient cleaners and wetting agents. A major problem has been the periodic disposal of varying amounts of these materials in the MBW or acid-alkali system. The combined affect of emulsifiers, oils, lubricants, wetting agents, etc. in the main flow system was counteracting our coagulating system. Not only was the sludge thinned out to a soupy consistency, but we were also faced with a problem of turbidity in the clarifiers.

The combination of these materials in even small doses, exhibits a strong tendency to resuspend solids which would otherwise precipitate very readily. Various agents and procedural changes have been tried to cope with the cleaner problem. Ferrous sulfate, aluminum sulfate and several commercial coagulants have had little affect. Probably the most effective agent in our system is the combination of treated chrome and transient fly ash. The fly ash, behaves like carbon and is continually recovered from flue gas in our chrome waste treatment process. Again, isolation and separate treatment was deemed most practical. The cleaners are now isolated at the point of origin. They are then transferred to and consolidated in a separate treatment basin, i.e. the former 75,000 gal. chrome basin, (Fig. 4) for acidification, coagulation and neutralization before disposal of the separated solids and removal of supernatant.

BLENDING SYSTEM

The blending tank already referred to is where all the pre-treated wastes plus lime, electrolytes, transient fly ash and

other coagulants are amalgamated before the final settling process. This tank is located between the two clarifiers (Fig. 4). There are, we feel, several advantages to blending the wastes outside of the clarifiers. The blending tank is a buffer zone which helps to minimize chemical as well as thermal shock to the clarifiers. These are important factors in minimizing solids resuspension within the clarifiers where our main concern is to maintain maximum possible quiescence. In addition, the use of the blending tank also permits earlier and isolates assimilation of all the various solutions outside of the clarifier. This results in a much more efficient operation and a correspondingly higher quality effluent. The proof of this is in the near perfect circle inscribed by the final effluent pH recording chart. With our new system a variance of more than a couple of tenths in pH over a 24 hour period is very rare.

SLUDGE

The precipitated sludge which begins forming in the blending tank settles in the clarifier. It is moved from the sloping bottom of the clarifiers into large sumps by means of slow moving arms.

The sludge that accumulates in these sumps is removed automatically by means of two large sludge pumps adjacent to the clarifiers. The sludge is pumped to two large thickening tanks. From here it is removed by a private hauler to a land fill operation.

It should be noted that the nature of the sludge is constantly changing. The consistency or liquid content is affected by the manufacturing plant activity. The liquid sludge rarely exceeds 5% solids and is more often closer to 3% solids.

Several years ago vacuum filters were used to help dehydrate the sludge. This idea was not practical for our type sludge. Filtering became less and less effective as pre-soaks, cleaners and emulsifying agents used in plating became more effective. Finally it became impossible to develop filterable sludge, and the vacuum filter process was abandoned in favor of land disposal. In this connection, we are now constructing on company property a sand-type filter bed 500 x 600 feet to be operated in series. It is expected this will be in operation late this spring.

CONTROLS

The entire treatment operation has been designed for early detection of any significant variables in the nature of the flow. The treatment plant personnel have been trained to be constantly on the alert for any deviation in either the composition or the quantity of the incoming flow. Continuous surveillance of the plating units themselves plus frequent sampling of the receiving tanks enables us to pinpoint a developing problem rather quickly.

All the critical flows are diverted through small sampling tanks for pH measurement. In addition to the acid-alkali flow, the tank undergoing treatment, the incoming chrome, the blending tank, and of course, the final effluent have their pH levels continuously indicated and recorded.

Finally, to show the purity of our effluent, we maintain an aquarium containing several fish. This aquarium is supplied by the same water going to the storm sewer.

SUMMARY

The collection and treatment of wastes from high volume production in a modern automotive electroplating plant is complex. The flow-through versus batch-type treatment is compared. The importance of segregation of the various types of wastes is emphasized. The flue gas method of chrome waste scrubbing has proven highly effective at this plant. Surveillance and continuous monitoring are likewise extremely important. A valuable adjunct to the system is an aquarium receiving flow from the final effluent stream.

Obviously both labor and chemical costs are substantial. We feel, however, that this is a necessary part of the many responsibilities in present day manufacturing. We realize also that pollution control is a grave responsibility. Construction of this plant is ample proof of our commitment.

With the operation of this plant, we at General Motors, Elyria feel we are meeting our responsibility to the community and public in general in this important area of pollution abatement.

Raymond Fisco
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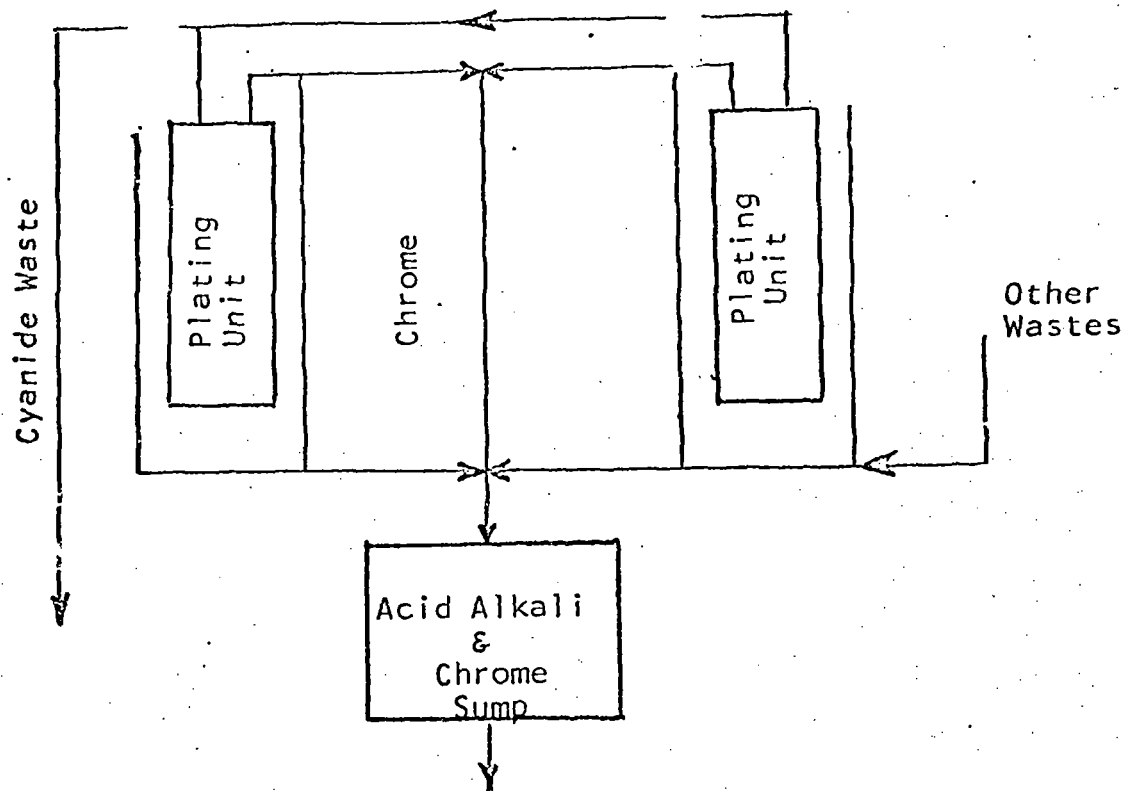


FIG. 1

Showing method of collecting plating and other mfg. wastes which flow by gravity to the acid alkali sump. Originally, all chrome wastes were also collected in this system. Cyanide remains segregated and is pumped to separate holding tanks.

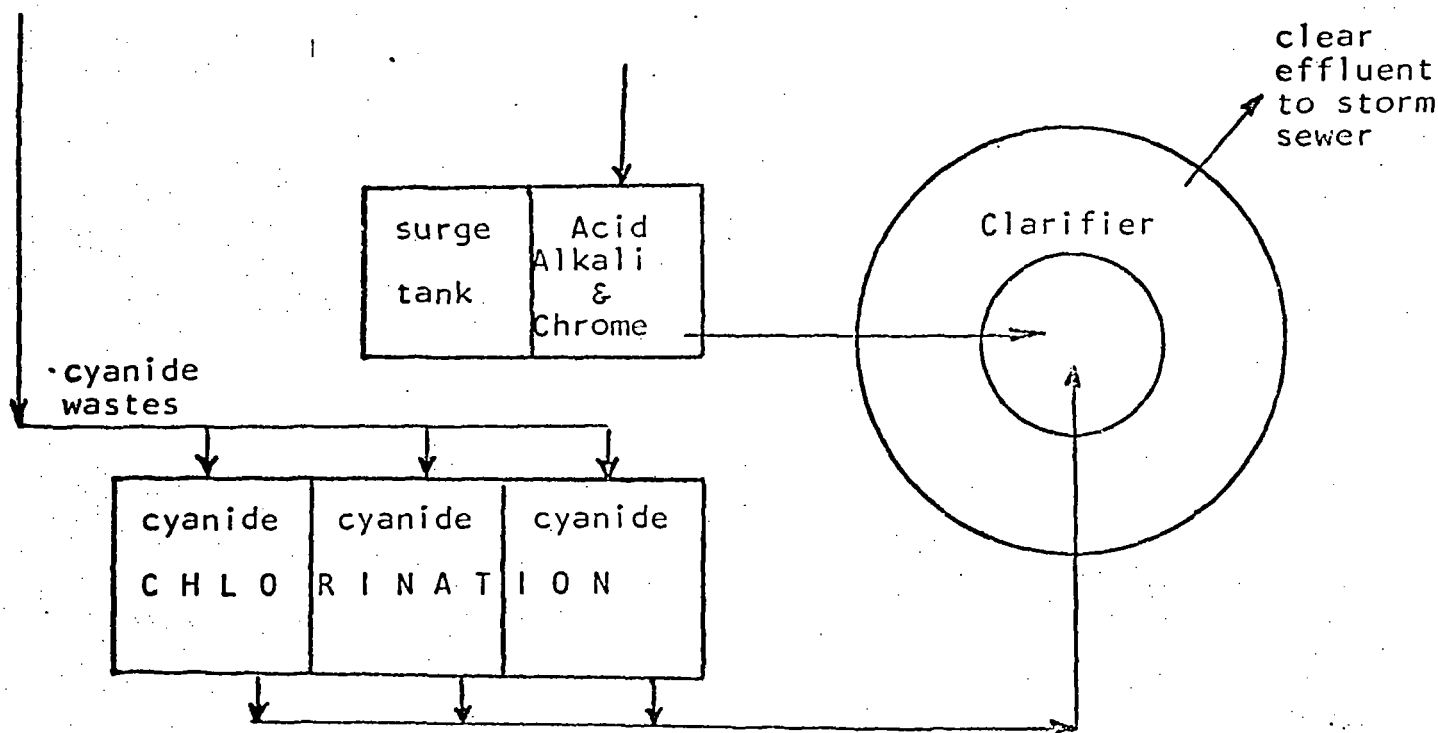


FIG. 2

Showing original treatment system. Acid alkali and chromic acid wastes were treated in a common tank. Cyanide is collected separately and treated with sodium hypochlorite. After initial treatment, all wastes were pumped to the clarifier draft tube for pH adjustment and clarification.

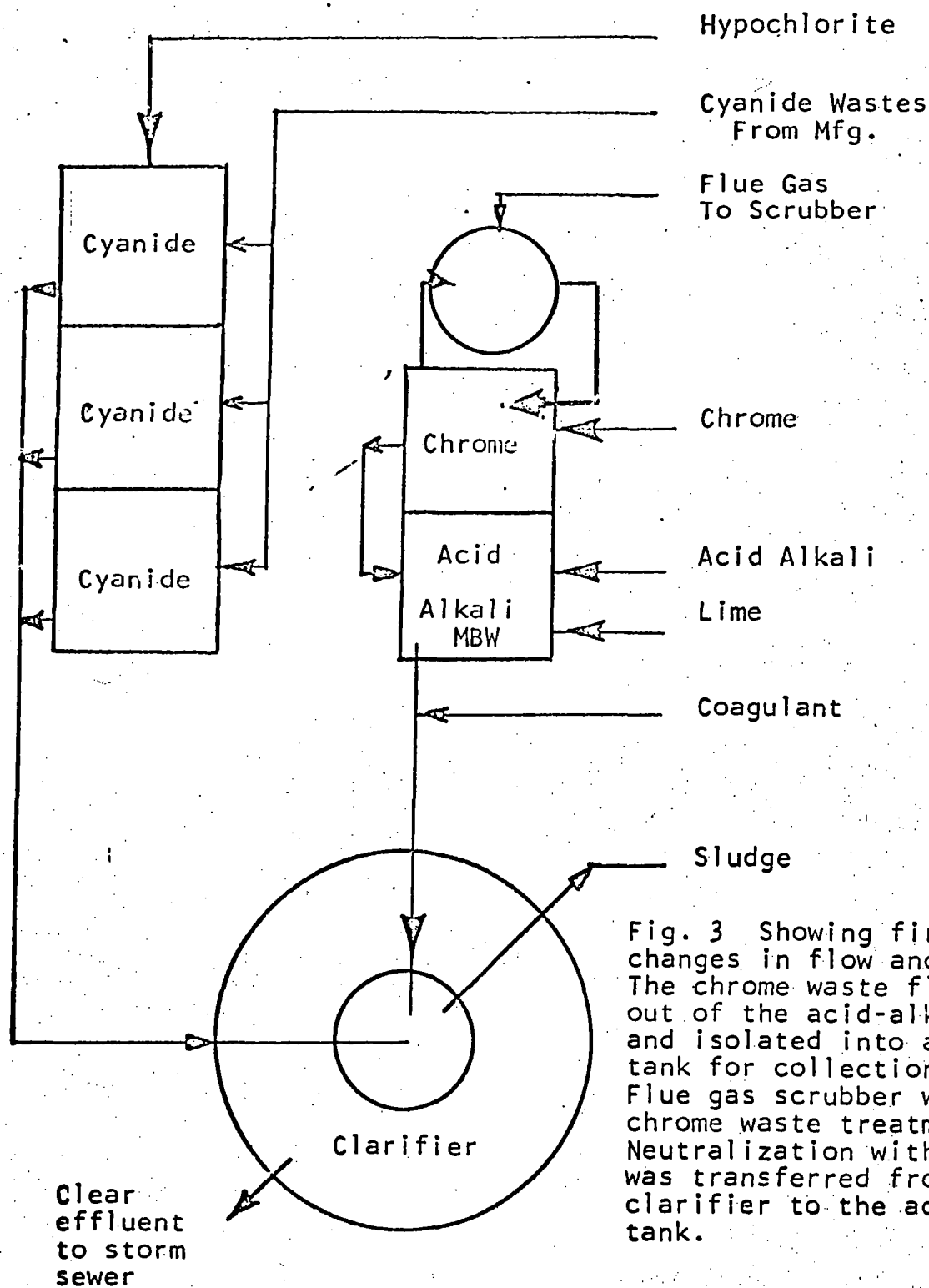


Fig. 3 Showing first major changes in flow and treatment. The chrome waste flow was taken out of the acid-alkali system and isolated into an adjoining tank for collection & treatment. Flue gas scrubber was added for chrome waste treatment. Neutralization with lime slurry was transferred from the clarifier to the acid alkali tank.